

Homework 3 – Transport Layer

Assigned: Tuesday, Oct 21, 2008

Due: Tuesday, Nov 4, 2008 *at the beginning of class*

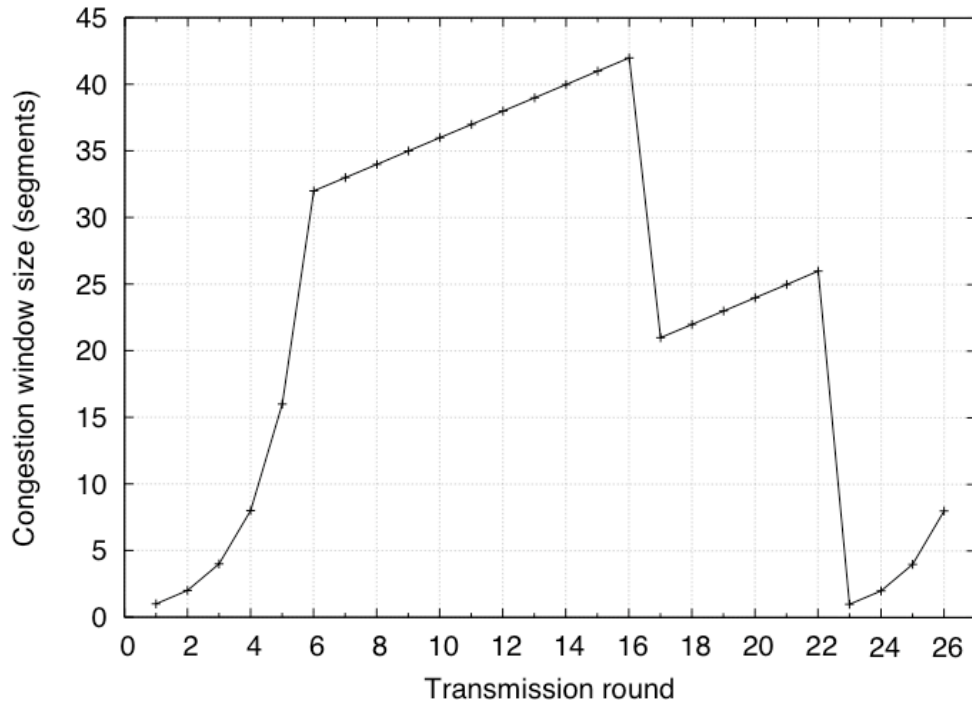
Review Questions [3 pts each]

1. What is the term for a transport-layer packet? a network-layer packet? a link-layer packet?
2. Suppose a process in Host C has a UDP socket with port number 6789. Suppose both Host A and Host B each send a UDP segment to Host C with the destination port number 6789. Will both of these segments be directed to the same socket at Host C? Why or why not?
3. What does it mean for a reliable transfer protocol to be stop-and-wait?
4. Briefly compare *and* contrast the Go-Back-N and Selective Repeat transfer protocols.
5. In a reliable transfer protocol, can a sender tell the difference between a lost data packet and a lost ACK?
6. How many sequence numbers are needed in a pipelined reliable transfer protocol to avoid ambiguity when the window size is w ?
7. What is the size of the TCP header without options?
8. What is the MSS?
9. Why shouldn't we set the TCP timeout value to be extremely large to avoid early timeouts?
10. What is the receiver's advertised window? How is it used by TCP?
11. Why does TCP need to exchange three packets during connection setup (3-way handshake)?
12. In what TCP state is all data transferred?
13. What are two symptoms of congestion?
14. During TCP congestion avoidance, how is the congestion window incremented? Answer the question for each ACK and for each RTT.
15. In TCP Tahoe, what happens to the congestion window and the slow-start threshold upon detecting a packet loss?
16. What is fast recovery?
17. [4 pts] According to the article "You Don't Know Jack About Network Performance", key factors that affect a network application's performance, besides bandwidth, are "network latency, transport protocol buffer management, congestion control dynamics, and the design of the application's protocol". Explain how each of these can affect a network application's performance.

Problems

1. Host A is sending a 20,000-byte file to Host B using a sliding window protocol. Packets are limited to 1000 bytes each, packets are numbered by packet number starting at 1, and the window size is 5 packets. Packet 7 is lost.
 - a. **[3 pts]** Which packets are retransmitted if Host A and Host B are using the Go-Back-N protocol?
 - b. **[3 pts]** Which packets are retransmitted if Host A and Host B are using the Selective Repeat protocol?
2. **[3 pts]** Draw a diagram of the packets exchanged in TCP connection setup between Host A and Host B. Include TCP flags, sequence numbers, and ACK numbers as appropriate. Assume that Host A's initial sequence number is 2312 and Host B's initial sequence number is 8888.
3. Consider that a TCP sender, Host A, wants to send 40,000 bytes to Host B. The maximum segment size (MSS) is 1460 bytes, the initial congestion window is 1460 bytes (1 MSS), and the initial slow-start threshold is 500 MB.
 - a. **[3 pts]** How many TCP segments will it take to send the 40,000 bytes?
 - b. **[3 pts]** How many RTT rounds will it take to send the 40,000 bytes, ignoring connection setup? (Consider that in one 'RTT round', an entire window's worth of packets is sent.)
4. **[4 pts]** Consider that a TCP sender, Host A, wants to send a 40,000,000-bit MP3 file to Host B. The slowest link between Host A and Host B is 5 Mbps, the RTT (including transmission delays) is 150 ms, and the TCP MSS is 12,000 bytes. The operating system of Host B sets a default receiver window of 16 segments. Assume that there is no congestion in the network. Will Host B be able to receive the file at 5 Mbps? Explain why or why not. If not, what would an appropriate receiver window size be?

5. Consider the following plot of the TCP Reno window size as a function of the transmission round (think RTT).



- [3 pts]** Identify the intervals of time when TCP slow-start is operating. How can you tell?
- [3 pts]** Identify the intervals of time when TCP congestion avoidance is operating. How can you tell?
- [3 pts]** After the 16th transmission round, is segment loss detected by a triple duplicate ACK or by a timeout? How can you tell?
- [3 pts]** After the 22nd transmission round, is segment loss detected by a triple duplicate ACK or by a timeout? How can you tell?
- [3 pts]** What is the initial value of the slow-start threshold at the first transmission round? How can you tell?
- [3 pts]** What is the value of the slow-start threshold at the 18th transmission round? How can you tell?
- [3 pts]** Assuming a packet loss is detected just after the 26th round by the receipt of three duplicate ACKs, what will be the values of the congestion window and the slow-start threshold in the 27th round?