

MIDTERM I
March 22, 2007
120 minutes

Name: _____

Student No: _____

Show all your work very clearly. Partial credits will only be given if you carefully state your answer with a reasonable justification.

Q1	
Q2	
Q3	
TOT	

1)

a) (2 pts each)

- i) Name an Internet application that works according to the client-server paradigm.
- ii) Name an Internet application that works according to the pure peer-to-peer paradigm.
- iii) Name an Internet application that works according to the hybrid client-server/peer-to-peer paradigm.
- iv) Name an application-layer protocol that is stateless.
- v) Name an application-layer protocol that maintains states.

b) A user at node A uses FTP to upload four files to node B before terminating the FTP session.

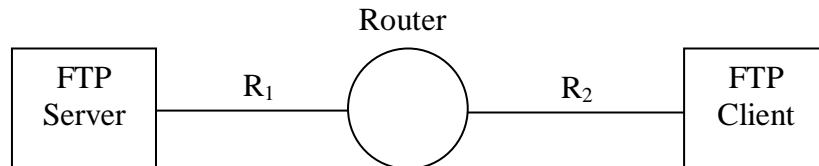
- i) (4 pts) Which of the two nodes is the client and which one is the server in this scenario? You need to briefly explain/justify your answer to receive credit.
- ii) (6 pts) How many TCP connections in total are established during the FTP session? You need to briefly explain/justify your answer to receive credit.
- iii) (6 pts) If we want to draw an analogy between FTP and HTTP, in what sense FTP establishes persistent connections, and in what sense it establishes non-persistent connections? You must briefly explain/justify your answer to receive credit.

c) (6 pts) Suppose you click on a link at your Web browser to download a Web page. Suppose that the IP address for the associated URL is not cached in your local host, so that a DNS look-up is necessary to obtain the IP address. Suppose that your local DNS server uses iterative queries and it contacts N DNS servers before sending your host the IP address of the requested Web server. Each successive contact incurs a delay of RTT_i , $i = 1, \dots, N$. Further assume that the Web page associated with the link contains exactly one object, a small HTML file with no other referenced objects. Let RTT_0 denote the delay between the local host and the Web server containing the object. Assuming that the transmission time of the object can be neglected, how much time elapses from the time when the client clicks on the link until the client receives the object?

d) (6 pts) TCP is a reliable transport layer protocol and the checksum field in a TCP segment is used towards ensuring reliability. But why does a UDP segment have a checksum field? Explain briefly.

2)

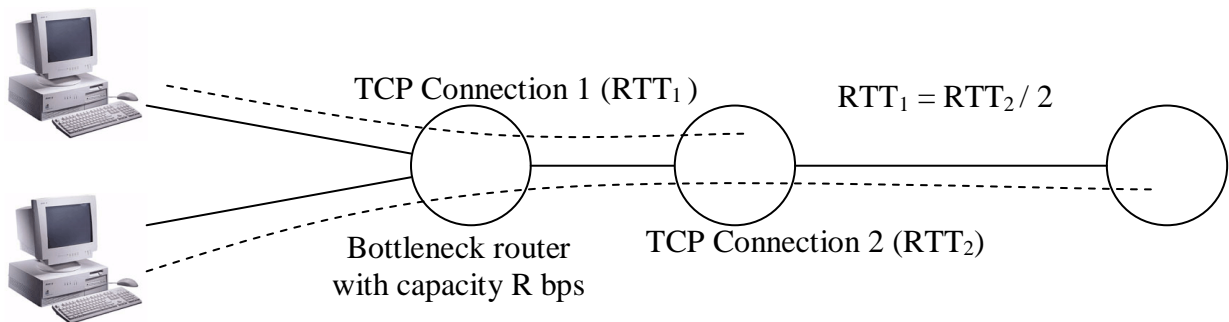
- a) Assume that there is a router and two links between an FTP server and an FTP client as shown below. The first link has transmission rate R_1 bps and the second link has transmission rate R_2 bps. Assume that the client wants to download a file, which is divided into three packets each of size L bits. Assume further that all propagation and processing delays are negligible.
- i) (6 pts) How long does it take from the time when the server starts sending the file until the client has received the whole file if $R_2 \geq R_1$?
- ii) (6 pts) How long does it take from the time when the server starts sending the file until the client has received the whole file if $R_2 < R_1$? How long does the second packet spend in the router's buffer?



- b) (12 pts) Consider a 1 Mbps channel with a 20 msec one-way propagation delay, i.e., 40 msec roundtrip propagation delay. We want to transfer a file of size 13500 Bytes. Each segment has a total size of 1625 Bytes including the 125 Bytes header, i.e., each segment contains 1500 Bytes of data. When there is data to be transmitted, each segment contains the maximum number of bytes. Assume that ACK segments are of 125 Bytes long and there is a processing delay of 1 msec after a segment is fully received at the receiver until the transmission of the corresponding ACK is started. **Go-Back-N** protocol is used with a window size of $N = 4$ segments. Assume that **every 6th segment** crossing the forward channel is lost while ACKs are not lost or corrupted. Assume that the processing delay at the sender after an ACK is received is negligible. How much time is required to complete the transfer of the whole file and receive the final ACK at the sender? Assume that the timeout for each window is set to 50 msec starting from the beginning of the window.
- c) (6 pts) Consider a transmission link running at 1 Gbps (1×10^9 bps). Assume that the speed of propagation is 3×10^5 km/s. What is the maximum distance between a TCP source and destination so that a window of size 100,000 Bytes can be fully utilized?

3)

- a) We would like to transfer a 6 MBytes (6×10^6 Bytes) file using TCP. Assume that the sender is in the slow start phase at the beginning of the file transfer and the slow start threshold is set to 10 MBytes. Assume further that TCP has been modified to allow very large windows so that the TCP receive window is always 4 MBytes (4×10^6 Bytes) during the entire connection. The distance between the sender and the receiver is 6000 km. Assume that the speed of propagation is 3×10^5 km/s. Each TCP segment has a size of 1000 Bytes. The transmission speed of the connection is 100 Mbps (100×10^6 bps). For simplicity, ignore processing and store-and-forward delays.
- (8 pts) Suppose no segments are lost. How long does it take to transfer the entire 4 Mbytes file?
 - (6 pts) What is the average channel utilization, U , during the transfer of the file?
 - (8 pts) Redo part i) if the TCP receive window is always 1 MBytes (1×10^6 Bytes) during the entire connection.
- b) (10 pts) Consider the case of two TCP connections sharing a single link with transmission rate of R bps, as shown in the figure below. Assume that two connections have the same MSS, but $RTT_1 = RTT_2 / 2$. Also assume that no other TCP connections or UDP datagrams use the shared link and no packets are lost except for the bottleneck router. Suppose that both TCP connections are operating in the AIMD mode at all times.



Similar to what we did in class, use the following figure in order to plot the time evolution of the joint throughputs realized by two connections assuming that the joint throughput initially starts at point A.

