

CS433/533: Computer Networks

Exam 1: Application, Transport, and Network

03/28/2005

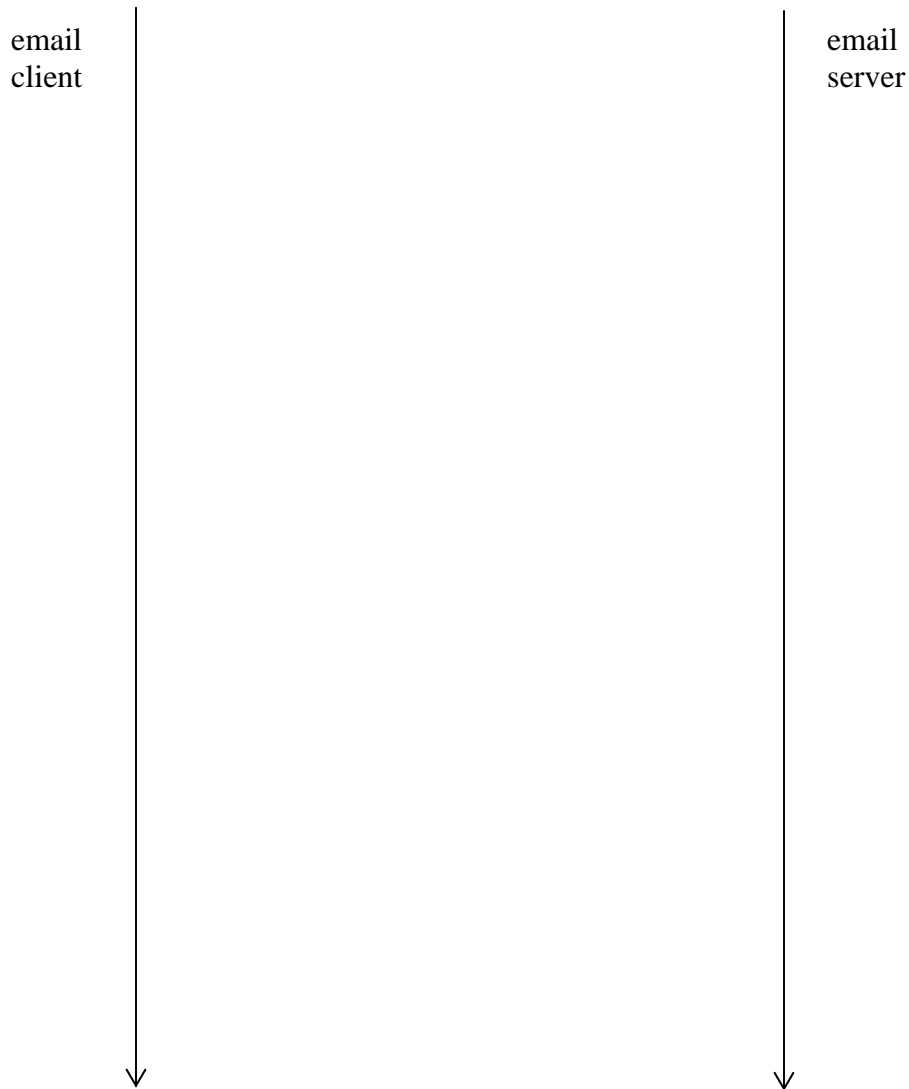
6:30-8:00 pm

- This exam is closed book and closed notes. However, you may refer to a sheet of 8.5"x11" paper of your own design.
- *Keep your answer concise.*
- Show your reasoning clearly. If your reasoning is correct, but your final answer is wrong, you will receive most of the credit. If you just show the answer without reasoning, and your answer is wrong, you may receive no points at all.

Name: _____

Applications (25 points)	Transport (27 points)	Routing (23 points)	Total (75 points)

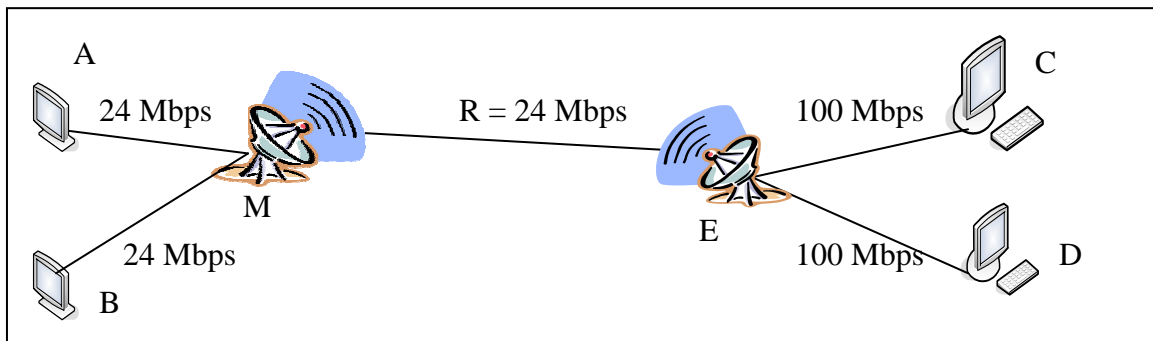
- d) [9 points] After obtaining the IP address of an email server, the email client and the email server use TCP to exchange email. Please illustrate the main messages exchanged, including TCP connection management messages.



- e) [4 points] The general practice is that it is the email client which performs `close()` first. Why is this so?

2. [27 points] Inter-planetary Reliable Transport

In 2010, a communication link between Earth and Mars is established. The figure below shows the setup of the communication network. The only wireless link in the network is the one between M (on Mars) and E (on Earth). The other links are wire-line links. All links in the network are bi-directional, and the bandwidth of each direction of each link is labeled in the figure. Assume packet size of the network is 10,000 *bytes*. The speed of light is 300,000 km/sec. Note that we use Mbps as 10^6 *bits* per second.



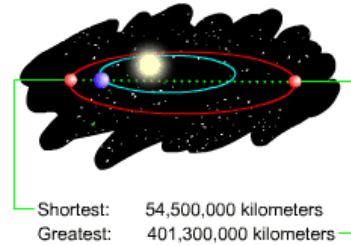
Your job, as a network designer, is to design a sliding window protocol to provide reliable, efficient transport utilizing this link.

- a) [3 points] We first consider the case that a single session (e.g., A transmits to C) is using the link. The session happens on March 28, 2010, when the distance between Earth and Mars is 150,000,000 km. What is the window size W of the session to efficiently utilize the link?

- b) [4 points] Suppose the network can only corrupt and drop packets. As in TCP, we assign seq# to each *byte*. If you are using go-back-n, what should the number of bits be for seq#? How about selective repeat?

- c) [4 points] Even when just one session is using the link, the window size W still should not be a constant across all time. Why?

Distance between Mars and Earth

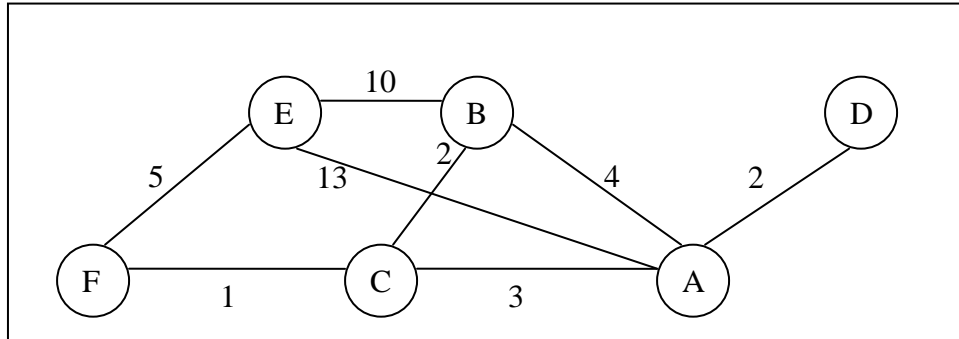


- d) [4 points] Since TCP congestion control can automatically discover the correct window size, one option is to use current TCP as the transport protocol. One argument against using TCP is that the bandwidth startup phase could be slow. Is this a valid argument? Please justify your answer quantitatively.
- e) [4 points] Another argument against TCP is that TCP considers packet losses as congestion indication. Estimation is that packet loss rate due to universe background radiation is 0.01%. Can TCP fully utilize the link, say in the scenario of (a)?

- f) [4 points] One approach to improving TCP performance under wireless packet losses is to modify the routers M and E (see page 6) so that they snoop passing DATA and ACK packets and retransmit automatically and transparently. For example, when such a router observes a new DATA packet, it caches the packet. When it observes triple-duplicate ACK, it automatically retransmits, on behalf of the sender. Do you think this is a good idea, or a bad idea? If you think this is a good idea, please state the key step to make it effective. If you think this is a bad idea, please state your major reason.
- g) [4 points] Another approach is to use the idea of TCP/Vegas by observing queueing delay instead of packet loss. Suppose we can guarantee that the link bandwidth is fully utilized by TCP/Vegas. Also, since TCP/Vegas style allocation implements Nash Bargaining Solution, its rate allocation scheme might be more convincing in allocating such a scarce resource. Suppose there are three concurrent long-living sessions: 1) A to C; 2) B to D; 3) A to B. Let x_1 , x_2 , and x_3 be the rates allocated to the three sessions. What are the values of x_1 , x_2 , and x_3 ? Hint: consider the optimization framework formulation; write down the objective function and a constraint for each involved link.

3. [23 points] Routing

Consider a network with 6 nodes: A, B, C, D, E, and F. We consider D as the destination.



- a) [5 points] Using the *synchronous* Bellman-Ford algorithm (SBF), please compute the routes to D. The initial distance estimation of all nodes except D is ∞ .

round	A	B	C	E	F	D
0	∞	∞	∞	∞	∞	

- b) [4 points] Few networks run SBF; instead they run asynchronous Bellman-Ford algorithm. Why not synchronous routing algorithms?

- c) [4 points] Synchronous or not, a serious problem of distance vector algorithms is the count-to-infinite problem. Can count-to-infinite happen to the network in Figure 4? If so, please indicate the event (i.e., link status change); if no, please state why.
- d) [5 points] The reason for count-to-infinite is state inconsistency, i.e., the next-hop relation of the nodes form a loop. We call such a loop next-hop state loop. Suppose the routing of a network has converged. Suppose we can only *decrease* the weights of some links (reconnecting a link is equivalent to decreasing the link weight from infinite to the finite weight). Can a next-hop state loop happen? If so, please give one example; if no, please state why?

- e) [5 points] Now suppose the routing protocol of the network is not distance vector, but BGP. The default route selection policy of each node is that a route with a shorter distance (as computed by distance vector in (a)) is more preferred. However, B has an exception in its route selection policy: its most preferred route is BEAD; otherwise, it is default. Node C also has an exception as well: it prefers CBAD the most; otherwise, it is default. Does the network have a stable BGP route selection? If so, please list the routes; otherwise, state why. Hint: list the first few highest ranked routes of each node.