This document contains 3 pages, 7 problems, maximum possible score: 98 points

14:332:423 Telecommunication Networks
Midterm Exam November 8, 2005

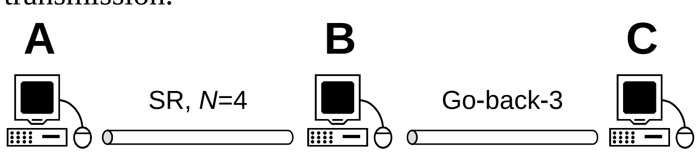
Problem 1 [8 points]

Consider a system using the Go-Back-*N* protocol over a fiber link with the following parameters: 10 km length, 1 Gbps transmission rate, and 512 bytes packet length. (Propagation speed for fiber $\approx 2 \times 10^8$ m/s and assume error-free communication.) What value of *N* achieves the maximum utilization of the sender?

Problem 2 [16 points]

Suppose three hosts are connected as shown in the figure. Host *A* sends packets to host *C* and host *B* serves merely as a relay. However, as indicated in the figure, they use different ARQ's for reliable communication (Selective Repeat vs. Go-back-*N*). Notice that *B* is *not* a router; it is a regular host running both receiver (to receive packets from *A*) and sender (to forward *A*'s packets to *C*). *B*'s receiver immediately relays in-order packets to *B*'s sender.

Draw side-by-side the timing diagrams for A→B and B→C transmissions up to the time where the first seven packets from *A* show up on *C*. Assume that the 2^{nd} and 5^{th} packets arrive in error to host *B* on their first transmission, and the 5^{th} packet arrives in error to host *C* on its first transmission.



Problem 3 [21 points]

Alice is a musician and she wants to send one of her new song to Bob using a MP3 file. The MP3 file consists 1 million (1×10^6) bytes. Assume that TCP is used and the connection crosses through 3 networks as shown in the figure below. Assume link layer header is 26 bytes, IP header is 20 bytes, and TCP header is 20 bytes, UDP header is 8 bytes.

(a) How many packets/datagrams are generated in Alice's computer on the IP level? Explain clearly your result. [5 points]

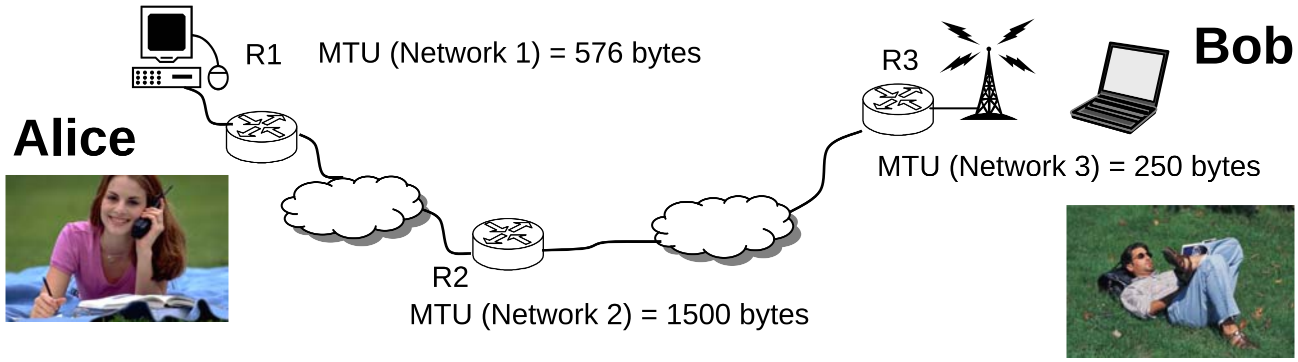
(b) How many fragments Bob receives on the IP level? Explain clearly your result. [5 points]

(c) Show the first 4 and the last 5 IP fragments Bob receives and specify the values of all relevant parameters (number of bytes, ID, offset, Flag) in each fragment header. Fragment number need to be stated. Assume initial ID = 543

[8 points]

(d) How much time it needs to finish the transmission from R3 to Bob's computer? Assume transmission delay, queuing delay, processing delay are all zero, the transmission rate is 100M bps from R3 to Bob's computer. [3 points]

***Show the work, not only the final result*.**

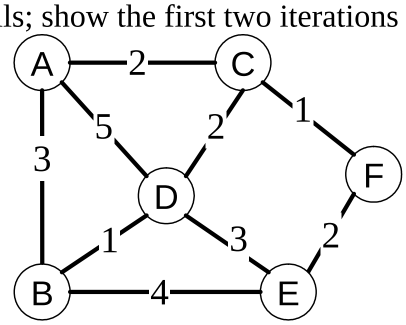


Problem 4 [15 points]

Consider the network shown below.

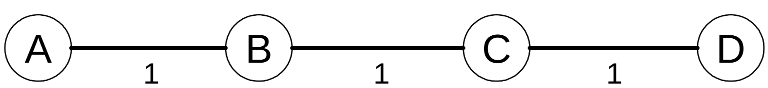
(a) Use distance vector routing (Bellman-Ford algorithm) to find the set of shortest paths from all nodes to destination node *B*.

(b) Suppose link *B*–*D* fails; show the first two iterations of what happens next.



Problem 5 [12 points]

Consider the following network, using distance-vector routing:



Suppose that, after the network stabilizes, link *F*–*G* goes down. Show the routing tables on the nodes *A*, *B*, and *C*, for the subsequent five exchanges of the distance vectors. How do you expect the tables to evolve for the future steps? State explicitly all the possible cases and explain your answer.

Problem 6 [16 points]

Multicast routing

Consider the network shown in the figure below, in which source *K* sends packets to multicast group *G*, whose members are all the shown hosts. Costs of all links are shown. Show how to build these multicast trees:

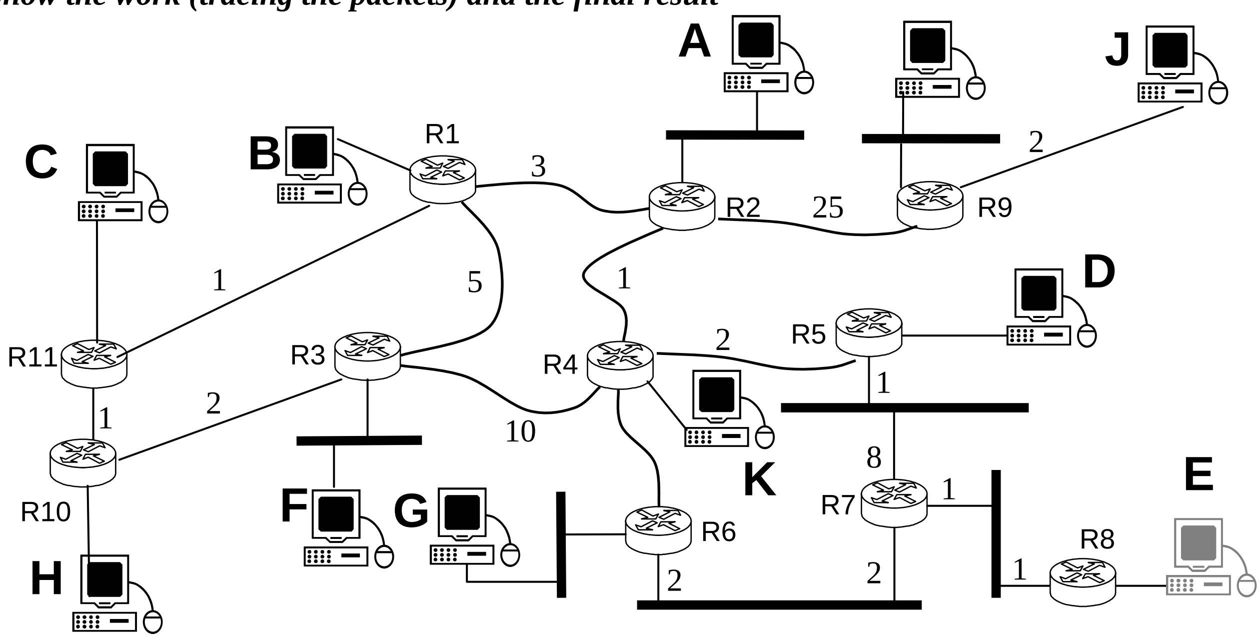
(a) Group-shared multicast tree assuming that R4 is the center node [7 points]

(b) Assume source is node *D*, RPF (reverse path forwarding) algorithm is used, how many total packets get generated in the entire network [7 points]

After the multicasting tree is built, suppose *H* leaves the group.

(c) The multicast features of RPF algorithm, such as pruning, is used. How many total packets get generated in the entire network per every packet sent by the source *D*? ***To avoid ambiguity, please explain clearly how you count the packets***. [2 points]

Show the work (tracing the packets) and the final result



Problem 7 [10 points]

Consider an $M/G/1$ queue with the arrival and service rates λ and μ, respectively. What is the probability that an arriving customer will find the server busy (i.e., serving another customer)? Explain your answer.