Computer Communication Networks
(Middle Term 2021/Spring)

系別：_____ 年級 ：_____ 學號 ：_____姓名 ：_____

1) (5%)

If two end-systems are connected through multiple routers and the data-link level between them ensures reliable data delivery, is a transport protocols offering reliable data delivery between these two end-systems necessary? Why?

2) (10%)

Consider sending a large file of F bits from Host A to Host B. There are three links (and two switches) between A and B, and the links are uncongested (that is, no queuing delays). Host A segments the file into segments of S bits each and adds 80 bits of header to each segment, forming packets of L = 80 + S bits. Each link has a transmission rate of R bps. Find the value of S that minimizes the delay of moving the file from Host A to Host B. Disregard propagation delay.

3) (10%)

Suppose users share a 3 Mbps link. Also suppose each user requires 150 kbps when transmitting, but each user transmits only 10 percent of the time.

a) When circuit switching is used, how many users can be supported?

b) For the remainder of this problem, suppose packet switching is used. Find the probability that a given user is transmitting.

c) Suppose there are 120 users. Find the probability that at any given time, exactly n users are transmitting simultaneously. (Hint: Use the binomial distribution.)

d) Find the probability that there are 21 or more users transmitting simultaneously.

4) (10%)

(i) Consider a new peer Alice that joins BitTorrent without possessing any chunks. Without any chunks, she cannot become a top-four uploader for any of the other peers, since she has nothing to upload. How then will Alice get her first chunk?

(ii) For the client-server application over TCP described in Section 2.7, why must the server program be executed before the client program? For the client- server application over UDP, why may the client program be executed before the server program?

5) (15%)

Consider distributing a file of F bits to N peers using a P2P architecture. Assume a fluid model. For simplicity assume that dmin is very large, so that peer download bandwidth is never a bottleneck.

a) Suppose that us ≤ (us + u1 + ... + uN)/N. Specify a distribution scheme that has a distribution time of F/us.

b) Suppose that us ≥ (us + u1 + ... + uN)/N. Specify a distribution scheme that has a distribution time of NF/(us + u1 + ... + uN).

c) Conclude that the minimum distribution time is in general given by max{F/us, NF/(us + u1 + ... + uN)}.

6) (10%)

Consider a DASH system for which there are N video versions (at N different rates and qualities) and N audio versions (at N different rate and qualities). Suppose we want to allow the player to choose at any time any of the N video versions and any of the N audio versions.

a) If we create files so that the audio is mixed in with the video, so server sends only one media stream at given time, how many files will the server need to store (each a different URL)?

b) If the server instead sends the audio and video streams separately and has the client synchronize the streams, how many files will the server need to store?

7) (10%)

(i) How is a UDP socket fully identified? What is the different between the full identification of both sockets?

(ii) Is it possible for an application to enjoy reliable data transfer even when the application runs over UDP? If so, how?

8) (10%)

Suppose that the UDP receiver computes the Internet checksum for the received UDP segment and finds that it matches the value carried in the checksum field. Can the receiver be absolutely certain that no bit errors have occurred? Explain.

9) (10%)

Consider the GBN protocol with a sender window size of 4 and a sequence number range of 1,024. Suppose that at time t, the next in-order packet that the receiver is expecting has a sequence number of k. Assume that the medium does not reorder messages. Answer the following questions:

a) What are the possible sets of sequence numbers inside the sender's window at time t? Justify your answer.

b) What are all possible values of the ACK field in all possible messages currently propagating back to the sender at time t? Justify your answer.

10) (10%)

Consider transferring an enormous file of L bytes from Host A to Host B. Assume an MSS of 536 bytes.

a) What is the maximum value of L such that TCP sequence numbers are not exhausted? Recall that the TCP sequence number field has 4 bytes.

b) For the L you obtain in (a), find how long it takes to transmit the file. Assume that a total of 66 bytes of transport, network, and data-link header are added to each segment before the

resulting packet is sent out over a 155 Mbps link. Ignore flow control and congestion control so A can pump out the segments back to back and continuously.