Mathematical and Computer Sciences and Engineering Division
Computer Networks (244)
Midterm Exam: Sunday Oct. 3rd 2010. 9:00-10:15 AM
Student Name: _____
Student ID: _____

You are to answer All Questions. Total time is 75 minutes

Question 1 (*Network & Internet*)

Consider sending a file *F* bits over a path of *Q* links. Each link transmits at *R* bps. The network is lightly loaded such that there are no queuing delays and propagation delay is negligible. When packet switching is used, the file *F* bits are broken up into *M* packets, each packet with *L* bits. *(5 Marks, 1 Mark each)*

a. How long does it take to send the file *F* over the path with *Q* links?

Time to transmit one packet over one link is L/R. time to deliver the first packet of the M packets to distention is QL/R. every L/R seconds a new packet from the M-1 remaining arrives. total time is L (Q+M-1)/R

b. Suppose the network is circuit switched. The time required to set the path is *T* seconds. For each packet the sending layers add a total of *h* bits of header. How long does it take to send the file from source to destination?

T + (L+h)(Q+M-1)/R

c. Suppose the network is a packet-switched and a connectionless service is used. Also, suppose each packet has *2h* bits of header. How long does it take to send the file?

(L+2h)(Q+M-1)/R

d. Suppose the network is a packet-switched and a connection-oriented service is used. Also, suppose each packet has *h* bits of header. A total of 3 extra packets are sent prior the actual file is transmitted to establish the connection (TCP handshaking). How long does it take to send the file?

3+ (L+h)(Q+M-1)/R

e. Suppose that the network is a circuit switched with transmission rate of *R* bps. Assuming *T* set-up time and *h* bits of header appended to the entire file, how long does it take to send the file?

No store and forward delay, then T+ (h+LM)/R

Question 2 (*Transport Layer*)

In TCP over heterogeneous networks *(5 Marks, 1 Mark each)*

a) Consider applications that transmit data at a constant rate. Suppose that a packet-switched network is used and the only traffic in this network comes from such applications. The sum of the application data rates is less that the capacities of each and every link. Is some form of congestion control needed? Justify your answer.

No. The total traffic does not exceed the available bandwidth, no contention or queuing delay. Soft traffic for the bandwidth

b) List the TCP congestion control phases and explain in one line the purpose of each phase.

Slow-start, congestion avoidance, fast retransmit, and fast recovery

c) Mention one problem induced when TCPs run over optical networks

Slow Convergence

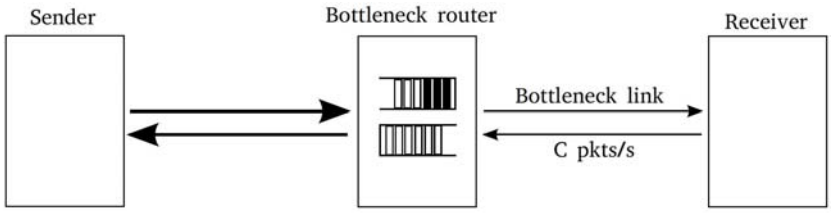
d) Name one TCP approach that assists dropping-based TCP over wireless networks

New-Reno, SACK, Duplicated SACK, Eifel, …etc.

e) Repeat (c) by replacing optical links with wireless links

False congestion detection

Question 3 (*Buffer Sizing*)



Recall Assignment 1, the buffer size at the bottleneck router determines the overall network throughput. Assume you are to determine the smallest optimal buffer size for a single TCP flow such that the bottleneck link is fully utilized (i.e., 100%). Assume the TCP congestion window grows up to *W* before the first packet is dropped. After this packet dropping, the window decreases to *W*/2. At this time the sender cannot transmit new packets because only *W*/2 packets can be in transit at a given time in the network. Assume the bottleneck link capacity is C pkts/s, TCP receiver acknowledges every received segment, and propagation delay is ignored. *(5 Marks, 1 Mark each)*

a) How long does it take for the receiver to acknowledge the receipt of *W*/2 packets?

(W/2)/C

b) Assume that the buffer size was *B* pkts when the first packet is dropped at the queue. How long does it take for the buffer to completely drain?

B/C

c) Obtain the relationship between *B* and *W* such that the bottleneck link stays operating at 100 % utilization?

(W/2)/C < B/C, or, B > W/2

d) Obtain the relationship between C and *W* such that the bottleneck link stays operating at 100 % utilization?

Sending rate R = W/RTT. When the sender starts retransmitting, its rate is (W/2)/RTT. If this rate is less than C, the bottleneck link is underutilized.
i.e., (W/2)/RTT > C, or W/2 > C * RTT.

e) What is the smallest optimal buffer size *B* in terms of bottleneck link capacity C and the TCP round trip time (RTT)?

Combining results from (c) and (d), B > C * RTT.

Question 4 (*Multiple Choice*)

Chose the correct answer *(5 Marks, 1 Mark each)*

1. In datagram network,
    a. Each packet carries tag to determines next hop
    b. Fixed path determined at call setup time
    c. Routers maintain per-call state
    d. Routes may change during session

2. In the congestion scenario when senders and receivers are connected through infinite buffers, they suffer from
    a. Transmission dropping
    b. Transmission delays
    c. Transmission delay and losses
    d. Transmission errors

3. End-to-End congestion control schemes,
    a. Requires explicit feedback from the network
    b. Identifies congestion from the network
    c. Requires explicit rate sender information
    d. Observes losses and delay without network assistant

4. TCP fairness is implemented by integrating
    a. Multiplicative increase, multiplicative decrease
    b. Additive increase, additive decrease
    c. Additive increase, multiplicative decrease
    d. Multiplicative increase, additive decrease

5. IP, which is layer 3 protocol is considered
    a. Connection less
    b. Connection-oriented
    c. Complex cell-oriented transmission system
    d. Complex frame-oriented transmission system