5510 Computer Networks

Mid-term Exam

59 points

3:45-5:00PM, October 19, 2017

Name:__________________________________

Instruction:

- This is a closed book and notes examination.
- You should read all of the questions before starting the exam, as some of the questions are substantially more time consuming.
- Be a smart exam taker. If you get stuck on one problem go on to another problem. Also, don't waste your time giving irrelevant (or not requested) details.
- Write all of your answers directly on this paper. *Keep your answers brief yet to the point.*

Problem 1: Quickies (33 points, and 3 points each question)

1. List the five protocol layers in the Internet protocol stack.

Application layer
Transport layer
Network layer
Link layer
Physical layer

0.6 pt each layer

2. Which layers in the Internet protocol stack does a router process?
   Physical layer, link layer & network layer (1 pt each)

3. List protocol layers for the three protocols shown in the table below.

Protocol	Protocol layer
HTTP	Application layer
TCP	Transport layer
UDP	Transport layer

1 pt each

4. What are four sources of packet delay?

   Nodal processing, queuing, transmission delay, & propagation delay
   (-0.7 pt fo each wrong answer)

5. Why do DNS queries and responses use UDP instead of TCP?

   UDP is faster due to no TCP connection setup that requires one RTT.
   UDP has a smaller header with 8 bytes.

6. Please list three benefits of using a web proxy.

    (1) Reduces user-perceived latency
    (2) Reduces bandwidth consumption
    (3) Reduces the web server load
    …

7. Where can a web cache be located or placed? List three locations we discussed in class.

    Web browser's local cache, web proxy, reverse proxy, …

8. Name five fields in a TCP segment header.
    Source port #, destination port #, sequence #, ack #, receiver window, ….
    (-0.6 pt for each wrong answer)

9. Suppose that all network sources (e.g., senders) are bursty – that is, they only occasionally have data to send. Would packet switching or circuit switching be more desirable in this case? Why?
    Packet switching is more desirable. – 1.5 pt
    Packet switching does not require setting up a connection to reserve resources for data transfer and it also maximizes bandwidth sharing (and thus bandwidth utilization) as the data is bursty. – 1.5 pt

10. What is DNS and what is it used for?
    DNS is Domain Name System. – 1.5 pt
    Return IP address(es) for a DNS name looup.

11. Circle one correct answer. In our Reliable Data Transfer (RDT) 3.0 protocol as discussed in class, negative acknowledgments (NAKs) are not needed because:
    (a) Sequence numbers are being used.
    (b) Timeouts and retransmissions are being used.
    (c) Checksums are being used.
    (d) It is a Stop-and-Wait protocol.

Problem 2: Our Reliable Data Transfer (RDT) protocol (6 points).
Consider a link of length 1000 miles with a 1 Gbps data rate connecting a sending and receiving node. Assume a fixed packet length of 1250 bytes. Assume that the sender always has packets to send. Finally, assume that packets are never lost or corrupted. (Based on propagation of about 1 foot per nanosecond and about 5000 feet in a mile, 1 nanosecond = 10^{-9} second)

Show your formula and calculation to get full credits.

(1) What is the utilization of this link for a stop-and-wait (SAW) protocol (i.e., reliable data transfer protocol 3.0 as discussed in class)? (4 points)
Transmission time = 1250 bytes / 1 Gbps = 0.01 msec
RTT = 2*(1000 * 5000 feet / 10^9 feet/sec) = 10 msec
Utilization = trans. time / (trans. time + RTT) = 0.01 / (0.01 + 10) = 0.1%

(2) What is the necessary window size to achieve 100% utilization for a sliding window (SW) protocol (i.e., pipelined protocols)? (2 point)
Let N be the window size, so we have
N*0.01/(0.01 + 10) = 100%
Then, we have N = 1001

Problem 3: Pipelined Protocols (6 points).
Compare GBN (Go-Back-N), SR (Selective Repeat) and TCP. Assume that the timeout values for all three protocols are sufficiently long such that 5 consecutive data segments and their corresponding ACKs can be received (if not lost in the channel) by the receiving host B and the sending host A, respectively. (In other words, there is no premature timeout) Suppose A sends 5 data segments to B, and the 2nd segment (sent from A) is lost. In the end, all 5 data segments have been correctly received by Host B. Assume that retransmission always succeeds.

How many segments has A sent in total and how many ACKs has B sent in total for all three protocols?

Protocol	# of Segments	# of ACKs
GBN	9	5, 6, 7, or 8 Due to cumulative acks
SR	6	5
TCP	6	5

Problem 4: HTTP Performance (8 points, 2 points each question).

Suppose the web page your web browser wants to download is 100K bits long, and contains 10 embedded images (with file names img01.jpg, img02.jpg, …, img10.jpg), each of which is also 100K bits long. The page and the 10 images are stored on the same web server, which has a 300 msec RTT from your browser. We will abstract the network path between your browser and the web server as a 100 Mbps link. You can assume that the time it takes to transmit a GET message into the link is zero, but you should account for the time it takes to transmit the base file and the embedded objects into the link. This means that the server-to-client link has both a 150 msec (assume symmetric propagation delay in both directions of the link) one-way propagation delay, as well as a transmission delay associated with it. In your answer, be sure to account for the time needed to set up a TCP connection (1 RTT).

(1) Assuming non-persistent HTTP and assuming no parallel connections are open between the browser and the server, how long is the response time – the time from when the user requests the URL to the time when the page and its embedded images are displayed? Be sure to describe components that contribute to this delay.

Trans. time = 100K bits / 100 Mbps = 1 msec
For each object: 1 RTT for TCP connection + 1 RTT + trans. time
So response time = 11 x (300 + 300 + 1) = 6611 msec

(2) Again assume non-persistent HTTP, but now assume that the browser can open as many parallel TCP connections to the server as it wants. What is the response time in this case?

Response time = 601 (for base file) + 300 + 300 + 10msec (parallel TCP connections for 10 images, but the server needs to take 10msec to upload 10 images)
= 1211 msec

(3) Now assume persistent HTTP (HTTP 1.1). What is the response time, assuming no pipelining?

Response time = 300 (TCP connection setup) + 301 x 11 (base file and images)
= 3611 msec

(4) Now suppose persistent HTTP with pipelining is used. What is the response time?

Response time = 300 (TCP connection setup) + 301 (base file) + 310 (images)
= 911 msec

Problem 5: TCP sequence number (6 points, 2 point each question).

Host A and B are communicating over a TCP connection, and Host B has already received from A all bytes up through byte 144. Suppose that Host A then sends two segments to Host B back-to-back. The first and second segments contain 20 and 40 bytes of data, respectively. In the first segment, the sequence number is 145, source port number is 303, and the destination port number is 80. Host B sends an acknowledgement whenever it receives a segment form Host A.

(1) In the second segment sent from A to B, what are the sequence number, source port number, and destination port number?

(2) If the first segment arrives before the second segment, in the acknowledgement of the first arriving segment, what is the acknowledge number, the source port number, and the destination port number?

(3) If the second segment arrives before the first segment, in the acknowledgement of the first arriving segment, what is the acknowledgment number?

(1)	Seq # = 165, source port # = 303, dest port # = 80
(2)	Ack # = 165, source port # = 80, dest port # = 303
(3)	Ack # = 145