Midterm Exam Review

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CSE353 – Into to Computer Networks

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Contents Covered (1)

- Overview of computer networks
  - Network structure - network edge, and network core
  - Network edge
    - end systems, access networks, links
  - Network core
    - packet switching
    - circuit switching
    - Internet strcuture
  - delay, loss, throughput in networks
  - protocol layers, internet protocol stack, ISO/OSI reference model

Content Covered (2)

- Application Layer
  - Priciples of network applications
  - Web and HTTP
  - Electronic mail -SMTP, POP3, IMAP
  - DNS
  - P2P applications
- Transport Layer
  - Transport layer services
  - Multiplexing and demultiplexing
  - UDP
  - principle of reliable data transfer
  - TCP
    - TCP segment structure, RTT estimation and timeout, reliable data transfer, flow control, connection management, congestion control

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Sample Question 1

Chapter 2

P1. True or false?

a. A user requests a Web page that consists of some text and three images. For this page, the client will send one request message and receive four response messages.

b. Two distinct Web pages (for example, `www.mit.edu/research.html` and `www.mit.edu/students.html`) can be sent over the same persistent connection.

c. With nonpersistent connections between browser and origin server, it is possible for a single TCP segment to carry two distinct HTTP request messages.

d. The `Date:` header in the HTTP response message indicates when the object in the response was last modified.

e. HTTP response messages never have an empty message body.

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Answer

- a) F
- b) T
- c) F
- d) F
- e) F

Sample Quetion 2

Chapter 1

P6. This elementary problem begins to explore propagation delay and transmission delay, two central concepts in data networking. Consider two hosts, A and B, connected by a single link of rate R bps. Suppose that the two hosts are separated by m meters, and suppose the propagation speed along the link is s meters/sec. Host A is to send a packet of size L bits to Host B.

a. Express the propagation delay, d_{prop}, in terms of m and s.

b. Determine the transmission time of the packet, d_{trans}, in terms of L and R.

c. Ignoring processing and queuing delays, obtain an expression for the end-to-end delay.

d. Suppose Host A begins to transmit the packet at time $t = 0$. At time $t = d_{\text{trans}}$, where is the last bit of the packet?

e. Suppose d_{prop} is greater than d_{trans}. At time $t = d_{\text{trans}}$, where is the first bit of the packet?

f. Suppose d_{prop} is less than d_{trans}. At time $t = d_{\text{trans}}$, where is the first bit of the packet?

g. Suppose $s = 2.5 \cdot 10^8$, $L = 120$ bits, and $R = 56$ kbps. Find the distance m so that d_{prop} equals d_{trans}.

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Answer

a) $d_{prop} = m / s$ seconds.

b) $d_{trans} = L / R$ seconds.

c) $d_{end-to-end} = (m / s + L / R)$ seconds.

d) The bit is just leaving Host A.

e) The first bit is in the link and has not reached Host B.

f) The first bit has reached Host B.

g) Want

$$m = \frac{L}{R} s = \frac{120}{56 \times 10^3} \left(2.5 \times 10^8\right) = 536 \text{ km.}$$

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Sample Question 3

Chapter 1

P8. 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. (See the discussion of packet switching versus circuit switching in Section 1.3.)

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.

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Answer

a) 20 users can be supported.

b) $p = 0.1$.

c) $\binom{120}{n} p^n (1-p)^{120-n}$.

d) $1 - \sum_{n=0}^{20} \binom{120}{n} p^n (1-p)^{120-n}$.

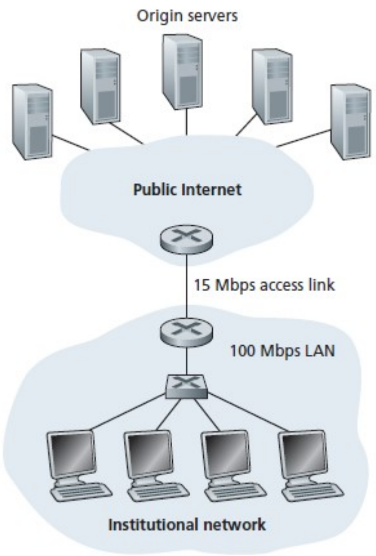
Sample Question 4

Chaper 2

P9. Consider Figure 2.12, for which there is an institutional network connected to the Internet. Suppose that the average object size is 850,000 bits and that the average request rate from the institution's browsers to the origin servers is 16 requests per second. Also suppose that the amount of time it takes from when the router on the Internet side of the access link forwards an HTTP request until it receives the response is three seconds on average (see Section 2.2.5). Model the total average response time as the sum of the average access delay (that is, the delay from Internet router to institution router) and the average Internet delay. For the average access delay, use $\Delta/(1 - \Delta\beta)$, where Δ is the average time required to send an object over the access link and β is the arrival rate of objects to the access link.

a. Find the total average response time.

b. Now suppose a cache is installed in the institutional LAN. Suppose the miss rate is 0.4. Find the total response time.



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Answer

- a)The time to transmit an object of size L over a link or rate R is L/R. The average time is the average size of the object divided by R:

  Δ = (850,000 bits)/(15,000,000 bits/sec) = .0567 sec

The traffic intensity on the link is given by $\beta\Delta$=(16 requests/sec)(.0567 sec/request) = 0.907. Thus, the average access delay is (.0567 sec)/(1 - .907) = .6 seconds. The total average response time is therefore .6 sec + 3 sec = 3.6 sec.

- b)The traffic intensity on the access link is reduced by 60% since the 60% of the requests are satisfied within the institutional network. Thus the average access delay is (.0567 sec)/[1 – (.4)(.907)] = .089 seconds. The response time is approximately zero if the request is satisfied by the cache (which happens with probability .6); the average response time is .089 sec + 3 sec = 3.089 sec for cache misses (which happens 40% of the time). So the average response time is (.6)(0 sec) + (.4)(3.089 sec) = 1.24 seconds. Thus the average response time is reduced from 3.6 sec to 1.24 sec.

Sample Question 5

Chapter 2

P10. Consider a short, 10-meter link, over which a sender can transmit at a rate of 150 bits/sec in both directions. Suppose that packets containing data are 100,000 bits long, and packets containing only control (e.g., ACK or handshaking) are 200 bits long. Assume that N parallel connections each get $1/N$ of the link bandwidth. Now consider the HTTP protocol, and suppose that each downloaded object is 100 Kbits long, and that the initial downloaded object contains 10 referenced objects from the same sender. Would parallel downloads via parallel instances of non-persistent HTTP make sense in this case? Now consider persistent HTTP. Do you expect significant gains over the non-persistent case? Justify and explain your answer.

Answer

Note that each downloaded object can be completely put into one data packet. Let Tp denote the one-way propagation delay between the client and the server.

First consider parallel downloads using non-persistent connections. Parallel downloads would allow 10 connections to share the 150 bits/sec bandwidth, giving each just 15 bits/sec. Thus, the total time needed to receive all objects is given by:

(200/150+Tp + 200/150 +Tp + 200/150+Tp + 100,000/150+ Tp)
+ (200/(150/10)+Tp + 200/(150/10) +Tp + 200/(150/10)+Tp + 100,000/(150/10)+ Tp)
= 7377 + 8*Tp (seconds)

Now consider a persistent HTTP connection. The total time needed is given by:

(200/150+Tp + 200/150 +Tp + 200/150+Tp + 100,000/150+ Tp)
+ 10*(200/150+Tp + 100,000/150+ Tp)
=7351 + 24*Tp (seconds)

Assuming the speed of light is $300*10^6$ m/sec, then Tp=10/($300*10^6$)=0.03 microsec. Tp is therefore negligible compared with transmission delay.

Thus, we see that persistent HTTP is not significantly faster (less than 1 percent) than the non-persistent case with parallel download

Sample Question 6

Chapter 2

P11. Consider the scenario introduced in the previous problem. Now suppose that the link is shared by Bob with four other users. Bob uses parallel instances of non-persistent HTTP, and the other four users use non-persistent HTTP without parallel downloads.

a. Do Bob's parallel connections help him get Web pages more quickly? Why or why not?

b. If all five users open five parallel instances of non-persistent HTTP, then would Bob's parallel connections still be beneficial? Why or why not?

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- a)Yes, because Bob has more connections, he can get a larger share of the link bandwidth.
- b)Yes, Bob still needs to perform parallel downloads; otherwise he will get less bandwidth than the other four users.

Sample Question 7

Chapter 2

P14. How does SMTP mark the end of a message body? How about HTTP? Can HTTP use the same method as SMTP to mark the end of a message body? Explain.

Answer

- SMTP uses a line containing only a period to mark the end of a message body.
- HTTP uses “Content-Length header field” to indicate the length of a message body.
- No, HTTP cannot use the method used by SMTP, because HTTP message could be binary data, whereas in SMTP, the message body must be in 7-bit ASCII format.

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Sample Question 8

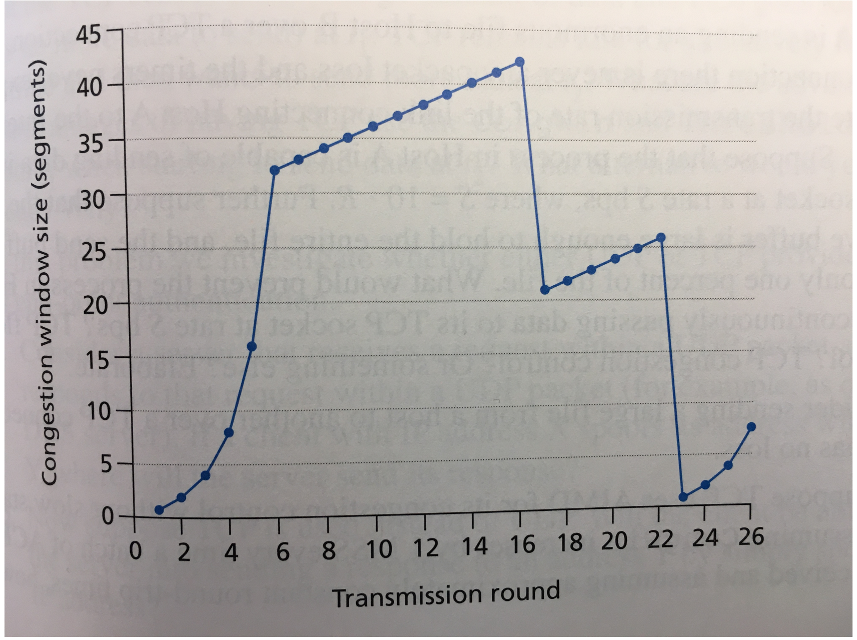
- Decribe why an applicaiton developer might choose to run an application over UDP rather than TCP.

Answer

- An application developer may not want its application to use TCP's congestion control, which can throttle the application's sending rate at times of congestion. Often, designers of IP telephony and IP videoconference applications choose to run their applications over UDP because they want to avoid TCP's congestion control. Also, some applications do not need the reliable data transfer provided by TCP.

Sample Question 9

- Consider the following plot of TCP window size as a function of time. Assume TCP Reno is the protocol used.
- (1) Identify the intervals of time when TCP slow start is operating.
- (2) Identify the intervals of time when TCP congestion avoidance is operating.
- (3) Identify the intervals of time when TCP fast recovery is operating.
- (4) After the 16th/22nd transmission round, is segment loss detected by a triple duplicate ACK or by a timeout?
- (5)What is the initial value of **ssthresh** at the first transmission round?
- (6) What is the value of **ssthresh** at the 18th and 24th transmission round respectively?



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Answer

- (1)TCP slowstart is operating in the intervals [1,6] and [23,26]
- (2)TCP congestion advoidance is operating in the interval [6,16]
- (3) TCP fast recovery is operating in the interval [17,22]
- (4) 16th: triple duplicate ACK, 22nd: timeout
- (5) 32
- (6) 18th: 21, 22nd: 13