NET ID _____

CS519, Final Exam (May 18, 2004)

NAME: _____

NETID: _____

You have **90 minutes** to complete the test. Note that there are a lot of questions, so if you get stuck on a question, move on and come back to it later. If you think you can answer a question without looking at your notes, you should probably do so and only go back and check your notes after you have completed the test.

It is possible to answer all questions in the space provided. You are free to use more space (margins, whatever), but if you feel you have to then it probably means you are giving a more complex answer than necessary.

Zero points will be awarded for any question left blank.

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Q1. 1 point

Write your NET ID at the top of every odd numbered page of this test.

Q2. 5 points

Imagine that you are designing a network, and you wish to maximize link utilization on this network. Check all that apply:

1. _____ Configure the queue sizes in your routers to be large

2. _____ Reduce the bandwidth of your links

3. _____ Deploy a traffic-sensitive dynamic routing algorithm

4. _____ Disable TCP congestion control on your hosts

5. _____ Enable fair queuing in your routers

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Q3. 5 points

Network "Power" is defined as *Power = Load / Delay*. Imagine that the most critical use of your IP network is high-quality voice telephony. In what region of the power curve shown below should you operate your network. Check one, and state your reasoning (and any assumptions):

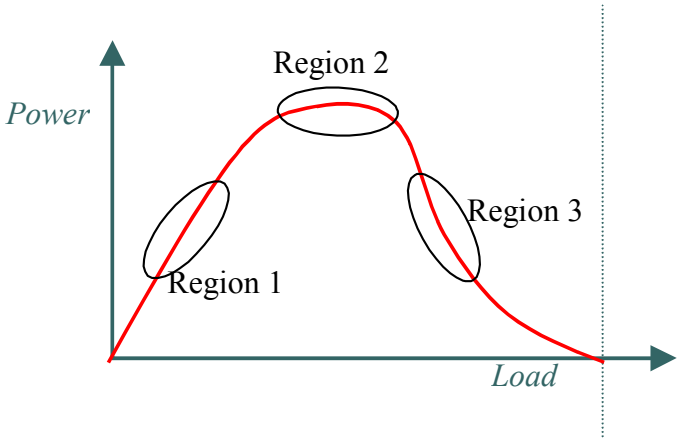
____ Region 1 ____ Region 2 ____ Region 3

_____

_____

_____

_____



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Q4. 6 points

Imagine you have three identical (but separate) wide area IP networks. Each network's users have broadband access to the network (around 400kbps), and the network itself is composed of high capacity links (several hundred Mbps). Assume that the first network is used for only voice over IP. The second network is used only for web browsing. The third network is used only for file transfer of full-length movies. Assume that the three networks all have the same volume of traffic (though not necessarily the same number of users), and that the network capacity is sufficient to handle the average load.

Now imagine that you can configure the queue buffer sizes in the routers. How would you configure the buffer sizes in order to have the same loss rates in all three networks (as measured in bytes dropped)? Check one:

1. _____ Identical buffer sizes across all three networks

2. _____ Different buffer sizes across all three network

If you checked number 2 (different queue sizes), which of the three networks (voice, movie, web) should have the largest queue sizes?

_____

Explain your reasoning, and assumptions (if any), regardless of which number you checked:

_____

_____

_____

_____

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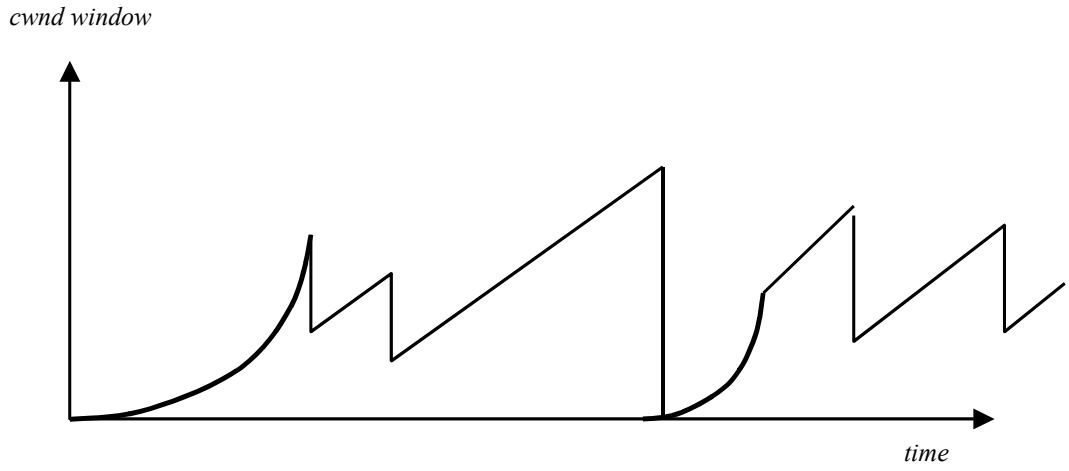
Q5. 6 points

In the box below, on the left, are listed three TCP header fields. On the right are five functions of TCP. Identify which TCP fields provide which functions (either explicitly or implicitly) by drawing lines between each field and the function or functions it provides. Note that any given field or function may have zero, one, or more than one line attached to it.

SequenceNum	Flow Control
	Demultiplexing
Acknowledgement	Congestion Control
	Byte Ordering
AdvertisedWindow	Reliable Byte Delivery

Q6. 5 points

In the TCP congestion window graph below, label the points where the pipe is most likely empty (i.e., no packets in transit from sender to receiver, and no ACKs in transit from receiver to sender).



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Q7. 6 points

Consider two hosts running TCP over a satellite link. The satellite link has a one-way latency of 100ms, and a bandwidth of 100Mbps which is a dedicated channel for the two hosts (by dedicated, I mean that only those two hosts use the channel…they get the full 100Mbps). Assume that the two hosts are using standard TCP slow-start and AIMD. Assume that the MSS (Maximum Segment Size) is 1000 bits (that is, the size of the packets transmitted by the sending host is 1000 bits). (Note that normally packet size is specified as bytes, but I'm using bits here just to make the arithmetic easier.) Finally, assume that the Advertised Window of the receiver is 160 Mbits.

From the beginning of transmission, approximately how long does it take for the throughput of the TCP connection to reach its maximum speed? Select one:

_____ 100ms

_____ 200ms

_____ 1.5 sec

_____ 3 sec

_____ 6 sec

Q8. 5 points

For the scenario of question Q7, what is the approximate average throughput achieved?

_____

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Q9. 6 points

For the scenario of question Q7, imagine that you can change the values of the MSS and the Advertised Window to any legal value (i.e. any value allowed by IP and TCP protocols). What values (if any) would you choose for these two parameters to maximize performance, and what effect would those changes have on performance?

New MSS value (if any)_____

Effect: _____

_____

_____

New Advertised Window value (if any)_____

Effect: _____

_____

_____

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Q10. 6 points

Assume that a router has three inputs, 1, 2, and 3, and one output. Assume that input 1 is four times faster than inputs 2 and 3, and that the output is considerably slower than any input. Assume three flows, each arriving on a separate input. Assume that at time T, the router's buffers are empty, and the following packets arrive back-to-back on their respective interfaces (where (A/100) means packet 'A' of size 100):

Input/flow 1: (A/100), (B/100), (C/100), (D100)
Input/flow 2: (E/50), (F/110), (G/200), (H/50)
Input/flow 3: (I/210), (J/80), (K/100)

Assuming fair queuing, in what order are the packets transmitted (list just the letter of the packet label, not the size)?

_____

Assuming weighted fair queuing, where flow 2 gets double the throughput of flows 1 and 3 (i.e., for every 2 bits transmitted for flow 2, flows 1 and 3 get one bit each), in what order are the packets transmitted?

_____

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Q11. 6 points

In RSVP, the host initiating the resource reservation initiates a PATH message, which records the path from the initiator to the receiver. The receiver subsequently returns a Reserve message along the reverse path. The reserve message is the message that actually establishes the reservation. Later, the initiator periodically "refreshes" the reservation. Routers will time-out and delete the reservation if it isn't refreshed within a certain period.

Part A: Why are the reservations made in the reverse direction instead of in the initial forward direction (as, for instance, is done in virtual circuit networks like X.25)?

_____

_____

_____

_____

Part B: Why is it necessary to record the path in the initial PATH message?

_____

_____

_____

_____

Part C: Why is the reservation periodically 'refreshed', rather than an alternative approach where the initiator explicitly removes the reservation when it is done? What are the disadvantages of this approach?

_____

_____

_____

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Q12. 4 points

What is the primary advantage of intserv over diffserv?

_____

_____

_____

_____

Q13. 4 points

What is the primary advantage of diffserv over intserv?

_____

_____

_____

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Q14. 5 points

In class, we argued that the three basic scaling mechanisms in the Internet are hierarchy, caching, and tunneling. Briefly describe how each of these mechanisms provide scalability, and give one example (from class) of each.

Hierarchy: _____

_____

_____

_____

Example: _____

Caching: _____

_____

_____

_____

Example: _____

Tunneling: _____

_____

_____

_____

Example: _____

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Q15. 5 points

Briefly describe what the two important functions served by the identification field of DNS are, and how they operate.

1: _____

_____

_____

_____

2: _____

_____

_____

_____

Q16. 4 points

Why is the DNS resolution function split between the end host (stub resolver) and its configured resolver?

_____

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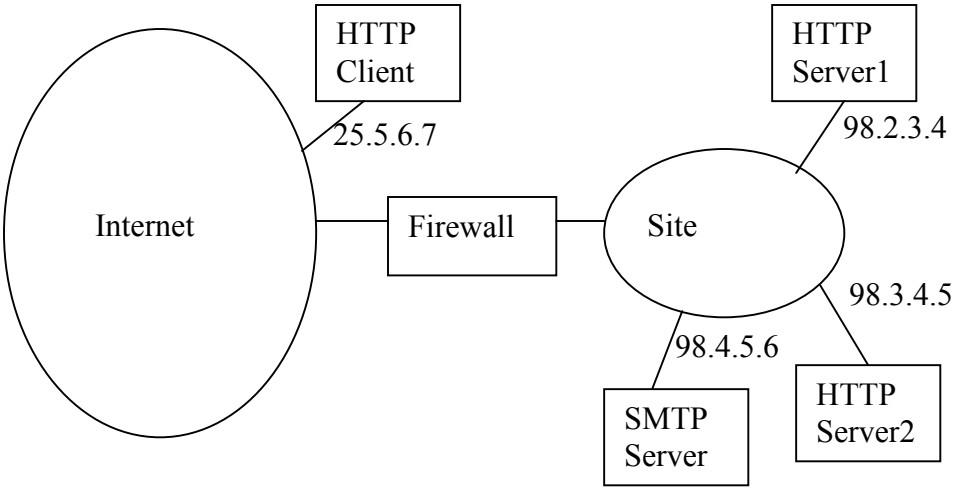

Q17. 6 points

Consider the firewall scenario depicted above. Using the table below, fill in the values that achieve the following policies. Assume that any policies not mentioned below are disallowed. Note that you may or may not need to fill in all rows. (The first policy is already filled in, as an example.)

- Any external host can access HTTP Server1.
- Any external host can access the SMTP server.
- Only the HTTP client shown can access HTTP Server2.
- Kazaa is allowed between any internal and external peers, in either direction, except for the SMTP server.
- HTTP is allowed from any internal host to any external host.
- Outgoing SMTP is allowed only from the SMTP Server.

	Source	Dest	App	Action
1	Any-outside	98.2.3.4	HTTP	Allow
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				

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Q18. 5 points

Now assume that the firewall used for question Q17 is also a NAT box. Assume that the NAT box has a single global address. List which rules from the table (by number) can still be made to work, and describe any configuration required at the NAT box, if any, to make those rules work.

_____

_____

_____

_____

List which rules cannot be made to work, and briefly describe why not.

_____

_____

_____

_____

Q19. 4 points

Why is it sometimes necessary for NAT to translate the TCP sequence numbers?

_____

_____

_____

_____

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Q20. 6 points

The following table lists a number of packets received by RTP. It shows the local time the packet was received, the timestamp of the RTP packet, and the sequence number of the RTP packet. Assume that the RTP timestamp is in units of 1ms. Assume that the granularity of the local clock is 1ms.

Local time	RTP Timestamp	RTP Sequence Number
5000	1000	100
5020	1020	101
5100	1040	102
5150	1200	104
5170	1240	106
5220	1220	105
5260	1260	107

For how many milliseconds should the receiver buffer incoming packets in order to be able to play all received packets back at the proper time?

_____

Now assume that the media stream is coded such that a single packet may be dropped every 300ms with no loss in quality, but that two or more dropped packets in a 300ms period would result in quality loss. Given this, how many milliseconds does the receiver need to buffer?

_____