Computer Science 125
Midterm - Spring 2014

Instructions – READ BEFORE STARTING

1. This exam is designed to be an *CLOSED BOOK*, **one seating**, **in-class** exam of **1.25 hours** which you are to complete as an individual.
2. Once you start this exam there is **NO** computer or web access. So put them away.
3. It is imperative that you **do not** discuss with any Claremont College student any material in this exam.
4. This examination has **five** questions.
5. The test is CLOSED book.
6. The questions are weighted as indicated.
7. **Do NOT** put any of these problems in a 'dorm' or 'student' test file.
8. Given under the HMC Honor Code. In short...Do your own work and follow the above directions!!
9. If you have **ANY** questions about a particular problem and I am not available, make an educated guess as to what is being asked and let me know how you interpreted the question.
10. If you have **ANY** issues with the above directions, please email or see me.

Problem 1 Multiple Choice

Each multiple choice correct answer is worth 1 point. Each multiple choice wrong answer is worth -1 point. **Circle ALL** that are true or apply.

1. When a TCP packet arrives at a host, in order to direct the segment to the appropriate socket, the operating system's network stack uses the following fields:

   - a. Transport protocol number
   - b. Destination IP address
   - c. Source port number
   - d. Destination port number
   - e. Destination MAC address

2. Which of the following is/are true about wireless networks?

   - a. All wireless networks must use access points.
   - b. The sender can always detect a collision without feedback from receiver.
   - c. Collisions are minimized when RTS/CTS mechanisms are used.
   - d. TCP congestion control mechanisms work poorly in wireless environments if they do not perform any type of link-layer retransmission.
   - e. Wireless networks generally have higher loss rates than that in wired networks.

3. Which of the following is/are true about routers?

   - a. Routers reassemble IP fragments if the next link can handle the full datagram.
   - b. Routers can arbitrarily drop packets if they want.
   - c. Routers can not change in anyway the IP packets they forward
   - d. On a router with many 1 Gbps ports, the router backplane can only handle 1 Gbps on the shared bus, leading to potential congestion.
   - e. In their line cards, routers lookup forwarding tables in the incoming direction and queue packets in the outgoing direction.

4. Dumbo built a home-brew network with 20 computers. The RTT between each computer is 10 ms. Communication between computers uses a simple UDP query and response protocol. If no response is received within 20 ms, a computer retransmits the request. Soon, Dumbo notices congestion collapse in his network. Which of the following techniques is/are guaranteed to prevent congestion collapse?

   - a. Double the timeout value from 20 ms to 40 ms.

- b. Increase the size of the queue in each router from 4 packets to 8 packets.
- c. Use exponential backoff in the timeout mechanism while retrying queries.
- d. If a query is not answered within a timeout interval, multiplicatively reduce the maximum rate at which the client application sends query packets.
- e. Use a flow control window at each receiver to prevent buffer overruns.

5. Which of the following statements is/are true about physical and link-layer protocols?

   - a. Manchester encoding requires that sender and receiver have clocks that run at approximately the same rate, so they can differentiate between the encoding of a single **0** and of multiple **0**s
   - b. Both Ethernet and 802.11 (Wifi) combine Carrier Sense with Collision Detection to ensure fair media access for multiple parties on a LAN.
   - c. When many hosts seek to actively communicate, token-ring schemes can achieve higher total output on a shared LAN than Ethernet.
   - d. An Ethernet adapter passes every non-corrupt frame that it receives up to the network layer.
   - e. Ethernet switches (as compared to hubs) eliminate the need for broadcasting packets to all hosts.

6. Which of the following statements is/are true about drop-tail and RED (random early detection) mechanisms in queues? Assume that these are always coupled with a FIFO scheduling policy. The full queue problem occurs if routers queues are often full and the lockout problem refers to a situation where a small number of flows monopolize the available queue space on a router.

   - a. Drop-tail solves the full queue problem.
   - b. RED solves the full queue problem.
   - c. RED solves the lockout problem for TCP flows.
   - d. Drop-tail has fewer burst losses than RED.
   - e. Both drop-tail and RED can be used with ECN (explicit congestion notification), so the router can signal congestion to the sender without dropping a packet.

7. Which of the following statements is/are true about fair queuing algorithms?

   - a. For a router serving n flows, fair queuing ensures that no flow can transmit at more than 1/nth the link's capacity.
   - b. Fair queuing is often used in the core of the Internet to minimize denial-of-service attacks by individual senders.

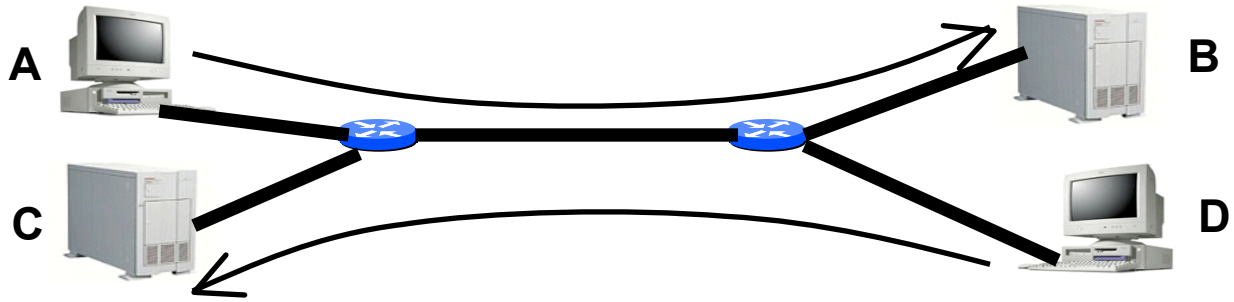
- c. Fair queuing algorithms conceptually track the number of bytes each flow consumes, rather than the number of packets
- d. Fair queuing algorithms can be based either on unique flows (5-tuples) or on unique classes of traffic (specified in the IP TOS field).
- e. Fair queuing with drop-tail policies experiences synchronized losses between multiple senders.

8. Which of the following applications use tunneling?

   - a. Virtual Private Networks
   - b. Network Address Translation
   - c. HTTP Proxying

9. A network (AS) C advertises the CIDR network number 192.3.48/20 (and no other numbers). What network numbers (all 24 bits) could AS C own?

   - a. 192.3.128
   - b. 192.3.49
   - c. 192.3.64
   - d. 192.3.1
   - e. 192.3.62



Problem 2 - Throughput (15 Points)

Suppose A has a TCP connection with B, where A sends data packets and B sends ACKs; similarly, suppose D has a TCP connection with C, where D sends data packets and C sends ACKs. Suppose the Maximum Segment Size (MSS) is 472 bytes, and all packets sent by A and D have this size; suppose also that B and C send an ACK in response to each data packet. Suppose that all packets have TCP and IP headers, as well as a 20-byte link-layer header/trailer. Assume the combined data and ACK packets fully utilize the middle link in both directions and no congestion control is applied. For the questions below if you do not remember the size of IP and TCP headers, choose a *reasonable* size and solve the problem.

- a. What fraction of the bandwidth is consumed by data traffic (i.e., the TCP data segments, rather than the transport, network, and link-layer information)? Feel free to express your answer as a reduced fraction (e.g., or) rather than a decimal number. Show your work.

- What if the MSS were increased to 1460 bytes? What is the new fraction?

- What if the MSS were increased to 1460 bytes, and the receivers apply the delayed-ACK mechanism to send an ACK for every other data packet? What is the new fraction?

Problem 3 - Sockets (15 Points)

Consider a Web server that generates and sends HTTP response messages to clients over sockets. The header of an HTTP response message consists of a collection of lines, each ending with a carriage return and line feed. For example,

HTTP/1.1 200 OK
Server: Apache/1.2.7-dev
Date: Tue, 07 Jul 1998 18:21:41 GMT
Content-Type: text/html

Some early Web-server software generated the lines one at a time, and used a separate system call to write (or send) each line to the socket.

1. Why is this approach inefficient for the end host?

2. Why is this approach inefficient for the network?

3. Describe how a programmer implementing the Web server software could fix this problem.

Problem 4 - Layering (20 Points)

1. Why do DNS queries and responses use UDP instead of TCP? Why do live audio and video traffic typically use UDP?

2. List three key reasons for a host to have both a domain name and an IP address.

3. Why has Network Address Translation been so widely deployed, despite the intent that it was meant to provide temporary relief from IP address space exhaustion until IPv6 could be designed and deployed?

4. Why does the Ethernet frame include a type field that indicates the network-layer protocol?

Problem 5 - Randomization (15 Points)

1. When starting a new TCP connection, why do the sender and receiver each pick a random initial sequence number (ISN)? Why not start every TCP transfer with a sequence number of 0?

2. Why does Random Early Detection (RED) selectively mark or drop some packets, even before the queue is full? Why is this done randomly, rather than deterministically? What are the implications if the mark/drop probability is set too high? Too low?

3. Why do Ethernet adaptors select a random back-off time before trying to transmit a frame following a collision? Why do they pick the random back-off time from a larger range after each collision?

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