New Mexico State University
Dept. of Computer Science
Computer Networks Qualifying Examination
Spring 2009

This examination is open book, open notes. Answer all questions.

1. (a) Recall that the amount of unacknowledged data in TCP is limited by three quantities: the congestion window size, the receive window size (flow control), and the RTT-bandwidth product. Is it possible for TCP Reno (the commonly used version) [10 points]

   i. to reach a state with congestion window size much larger than RTT×bandwidth? How likely is it?

   ii. to reach a state with congestion window size much larger than the receive window? How likely is it?

   (b) The Nagle algorithm, built into most TCP implementations, requires the sender to hold a partial segment's worth of data (even if PUSHed) until either a a full segment accumulates or the most recent outstanding ACK arrives. Suppose a fast typist who can do 100 words a minute (with each word of average 6 characters) is feeding a TCP client application that is sending the text to a server. Indicate how many bytes are contained in each segment sent by the TCP client in the following cases: [10 points]

   i. The client and server are in the same LAN and the RTT is 20 ms.

   ii. The client and server are across a WAN and the RTT is 100 ms.

   (c) Being motivated by the idea of aware networking, a new network application programmer decides that for his video application to recover from losses over the Internet he should set the video buffer playout time exactly equal to the current average RTT to the sender. While he runs his multimedia application playing videos from all around the world, he notices that for larger RTT values his video works fine while for shorter RTT values his video misses several frames. [10 points]

   i. What is the mistake that he made?

   ii. He also suggests that since there are negligible losses to stream from a server within the US, the streaming multimedia player can get rid of the playback buffer once a US-based server is identified. What would be your response to this suggestion?

2. (a) Consider the situation where Host A is on LAN 1 and Host B is on LAN 2, and the Router R directly connects the two LANs. The MTUs of the two LANs are 1500 bytes and 512 bytes respectively. Suppose an application running on Host A executes 1000 writes to an application running on Host B, each write resulting in a full one-MTU sized IPv4 datagram on LAN 1, with the minimal IP header (no options). How many datagrams from Host A to Host B traverse LAN 2? What are their sizes and offset field values? (Assume that there is no path MTU discovery.) [10 points]

   (b) Consider routing IPv6 datagrams using an IP tunnel over a path involving IPv4-only routers. Suppose that there are 22 actual hops from source S to destination D, but 7 of the hops are through a IPv6-in-IPv4 tunnel. If S sets the TTL of a datagram to 31, what would be the value of TTL when it reaches D? [5 points]

   (c) Recall that IPv6 datagram can be fragmented only at the time of its formation at the source S, is it possible that the IPv4 datagrams implementing the tunnel get fragmented? Justify your answer briefly with appropriate assumptions. [5 points]

   (d) Consider the way mobile-IP uses tunneling for implementing a single level of indirection in datagram forwarding. The mobile station does not change its native IP address even while in a foreign subnet, but registers the IP address to the foreign agent, which in registers itself to the station's home agent. All datagrams destined to the mobile station actually go to the home agent first, and then gets tunneled to the mobile station via the foreign agent currently registered.

   Now think about an alternative solution that attempts to replace the indirection in packet forwarding with an indirection in name resolution. This is based on the assumption that the corresponding agent never makes a TCP connection to a mobile host without making a DNS query first. Sketch an end-to-end approach to tackle host mobility by using very short DNS record TTL (similar to dynamic DNS, but for avoiding the tunneling and triangle routing of mobile IP.) Compare the capability of maintaining a long TCP session with a highly mobile host between mobile IP and the DNS-based approach. [15 points]

3. (a) A network administrator discovers that one of the hosts connected to the gigabit Ethernet LAN has been compromised and converted to a rogue station. Every time any host transmits a frame over its Ethernet interface, the rogue station sabotages the transmission by beginning a competing transmission as soon as it hears the beginning of the transmitted frame, causing a collision. He needs your help to estimate the approximate distance (in terms of cable length, in meters) of the rogue station from one or more probing hosts. On one of these probe stations, you notice that the collision is detected during the transmission of its 12th byte on the wire (including any preamble, etc.). Given that the speed of the signal in the wire is 2×10^8 meters/second, how far away is the rogue station from your machine? [5 points]

   (b) Suppose you have installed an aware networking protocol stack as part of a new experimental OS kernel on your Wi-Fi capable PDA. On the PDA, you typically use one primary network application at a time, and traffic due to application mixes is not a very important consideration. You have a choice of three user selectable MAC protocols to be associated with each network application program, namely TDMA, CSMA/CA with RTS/CTS disabled, and full CSMA/CA (with RTS/CTS). Assume that the access points support on-the-fly negotiation of MAC choices with each individual mobile station. For each of the following three applications, select the MAC protocol you would like to associate explaining your reasons: [15 points]

      i. VoIP phone calls
      ii. MPEG mobile TV streaming
      iii. Instant Messenger chat

   (c) At what layer would you try to provide mobility support for wireless users based on its granularity, when moving [15 points]

      i. within a room or between neighboring rooms in the Science Hall.
      ii. between two buildings in the NMSU main campus.
      iii. between NMSU main campus and the new Starbucks across University Avenue and Espina.

   (Explain your own answers briefly justifying your solution based upon the kind of Internet access that you think you would have.)