CSE 473 – Introduction to Computer Networks

Quizz 1 Solution

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1. (2 points) You are transmitting a 10,000 bits packet over a 2,000 km fiber optic link. How fast/slow should the transmission rate on the link be so that the propagation delay on the link is approximately equal to the packet transmission time?

   The propagation delay on a 2,000km link is approximately 2,000/200,000=10 msec. The transmission time of a 10,000 bits packet on a link of speed c bits/sec is 10,000/c, so that 10,000/c = 10 msec implies c =10^6 = 1 Mbps.

2. (3 points) Packets arrive at an average rate of 100,000 packets per second at a router queue that can hold 500 (average size) packets and that feeds a 1 Gbps (10^9 bits/sec) link. The average packet length is 5,000 bits. What is the traffic load or intensity on the link? What is the average number of packets in the queue? How does this value change if the packet arrival rate increases to 200,000 packets/sec?

   *The traffic load is 100,000*5,000/10^9 = 0.5.*

   The average number of packets in the queue is 0.5/0.5 = 1 packet.

   If the packet arrival rate increases to 200,000 packets/sec, the traffic load is now equal to 1. We cannot use the $\rho/(1-\rho)$ expression anymore, and need to resort to using the more accurate "finite queue" expression. However, for $\rho=1$ the expression is indefinite, i.e., of the form 0/0, and we need to either use L'Hôpital's rule or polynomial factorization. As mentioned in class, when $\rho=1$, this then yields an average number of packets in the queue equal to half the maximum queue size, i.e., in our case the average queue size for $\rho=1$ is 250 packets.

3. (5 points) A user connects to the Internet via a 2 Mbits/sec DSL connection and accesses the New York Times web page. The page itself is 275 kbytes and includes references to a total of 100 images and objects, each on average 25 kbytes (you can assume that 1 kbytes = 1,000 bytes). The roundtrip time (RTT) between the user and the server hosting the web page is 20 msecs.

   Approximately how long does it take for the page (including images) to appear on the user's screen, assuming persistent HTTP?

   The request starts with the establishment of a TCP connection, which requires 1 RTT = 20 msecs.

   *This is followed by the request for the main page and its transmission, which takes 1 RTT + 275,000*8/2,000,000 = 0.02 + 1.1 = 1.12 secs.*

   *Finally, the 100 images are requested and transmitted back, which takes 1 RTT + 100*25,000*8/2,000,000 = 10.02 secs.*

   So that the total download time equals 11.16 secs (3 RTTs plus transmission times)

   How long would it take using non-persistent HTTP (assume a single connection at a time)?

   As shown in the class slides, with non-persistent HTTP new TCP connections are required for each individual object in the page, the total download time requires 2(1 + number of images/objects in page)RTTs plus the transmission times of the page and the 100 images/objects. This amounts to

   *2*101*0.02 + 1.1 + 10 = 15.14 secs*