

Computer Networking

Homework#1

1. Suppose Host A wants to send a large file to Host B. The path from Host A to Host B contains three hops (links), with the link rates of these hops of rates $R_1 = 500$ kbps, $R_2 = 2$ Mbps, and $R_3 = 1$ Mbps. That is, the file sent by Host A must pass through two immediate routers to reach Node B.
 - (a) Assuming no other traffic in the network, what is the throughput for the file transfer.
 - (b) Repeat (a), but now with R_3 reduced to 200 Kbps.
2. Suppose users share a 2 Mbps link. Also suppose each user requires 100 Kbps when transmitting, but each user transmits only 20% of the time in average. (You may review the concept of statistical multiplexing for solving this problem)
 - (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 40 users. Write the formula of the following probability: P(at any given time, exactly n users are transmitting simultaneously). (*Hint*: Use the binomial distribution.)
 - (d) Suppose there are 40 users again. Write the formula of the following probability: P(21 or more users transmitting simultaneously).
3. Consider the queuing delay in a router buffer (preceding an outbound link). Suppose all packets are L bits, the transmission rate is R bps and that N packets simultaneously arrive at the buffer every LN/R seconds. Find the average queuing delay of a packet. (*Hint*: The queuing delay for the first packet is zero; for the second packet L/R ; for the third packet $2L/R$. The N th packet has already been transmitted when the second batch of packets arrives.)
4. Consider a packet of length L which begins at end system A, travels over one link to a packet switch, and travels from the packet switch over a second link to a destination end system. Let d_i , s_i , and R_i denote the length, propagation speed, and the transmission rate of link i , for $i = 1, 2$. The packet switch processes and delays each packet by d_{proc} . Assuming no queuing delays, in terms of d_i , s_i , R_i , ($i = 1, 2$), and L , what is the total end-to-end delay for the packet? Suppose now the packet length is 1,000 bytes, the propagation speed on both links is $2 \cdot 10^8$ m/s, the transmission rates of both links is 2 Mbps, the packet switch processing delay is 1

msec, the length of the first link is 4,000 km, and the length of the last link is 1,000 km. For these values, what is the end-to-end delay?

5. What are the five layers in the Internet protocol stack? What are the principal responsibilities of each of these layers?