Assignment

1) Compare the delay in sending an x-bit message over a k-hop path in a circuit-switched network and in a (lightly loaded) packet-switched network. The circuit setup time is $s$ sec, the propagation delay is $d$ sec per hop, the packet size is $p$ bits, and the data rate is $b$ bps. Under what conditions does the packet network have a lower delay?

2) Suppose that $x$ bits of user data are to be transmitted over a k-hop path in a packet-switched network as a series of packets, each containing $p$ data bits and $h$ header bits, with $x \gg p+h$. The bit rate of the lines is $b$ bps and the propagation delay is negligible. What value of $p$ minimizes the total delay?

3) Calculate the total time required to transfer a 1.5-MB file in the following cases, assuming a round trip time (RTT) of 80 ms, a packet size of 1 KB and an initial $2 \times$ RTT of "hand-shaking" before data is sent.

(a) The bandwidth is 10 Mbps, and data packets can be sent continuously.

(b) The bandwidth is 10 Mbps, but after we finish sending each data packet we must wait one RTT before sending the next.

(c) The link allows infinitely fast transmit, but limits bandwidth such that only 20 packets can be sent per RTT.

(d) Zero transmit time as in (c), but during the first RTT we can send one packet, during the second RTT we can send two packets, during the third we can send four = $2^{(3-1)}$, and so on.