

Chapter 1 Assignments

1. Calculate the total time required to transfer a 1000-kB file in the following cases, assuming an RTT of 100 ms, a packet size of 1 kB data, and an initial $2 \times \text{RTT}$ of “handshaking” before data are sent.
 - (a) The bandwidth is 1.5 Mbps, and data packets can be sent continuously.
 - (b) The bandwidth is 1.5 Mbps, but after we finish sending each data packet, we must wait one RTT before sending the next.
 - (c) The bandwidth is “infinite,” meaning that we take transmit time to be zero, and up to 20 packets can be sent per RTT.
 - (d) The bandwidth is infinite, and during the first RTT, we can send one packet (2^1-1), during the second RTT we can send two packets (2^2-1), during the third we can send four (2^3-1), and so on.
2. This elementary problem begins to explore propagation delay and transmission delay, two central concepts in data networking. Consider two hosts, A and B, connected by a single link of rate R bps. Suppose that the two hosts are separated by m meters, and suppose the propagation speed along the link is s meters/sec. Host A is to send a packet of size L bits to Host B.
 - (a) Express the propagation delay, d_{prop} , in terms of m and s .
 - (b) Determine the transmission time of the packet, d_{trans} , in terms of L and R .
 - (c) Ignoring processing and queuing delays, obtain an expression for the end-to-end delay.
 - (d) Suppose Host A begins to transmit the packet at time $t=0$. At time $t=d_{trans}$, where is the last bit of the packet?
 - (e) Suppose d_{prop} is greater than d_{trans} . At time $t=d_{trans}$, where is the first bit of the packet?
 - (f) Suppose d_{prop} is less than d_{trans} . At time $t=d_{trans}$, where is the first bit of the packet?
 - (g) Suppose $s=2.5 \times 10^8$, $L=120$ bits, and $R=56$ kbps. Find the distance m so that d_{prop} equals d_{trans} .
3. 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?
4. A system has an n -layer protocol hierarchy. Applications generate messages of length M bytes. At each of the layers, an h -byte header is added. What fraction of the network bandwidth is filled with headers?
5. What are two reasons for using layered protocols? What is one possible disadvantage of using layered protocols?