COMP2190 – Semester 1 2020/2021

Tutorial 1

Problems

1. What are two reasons for using layered protocols? What is one possible disadvantage of using layered protocols? [1, prob. 10]

2. Which of the layers in the reference model reviewed in lecture handles each of the following:
   a. Dividing the transmitted bit stream into frames.
   b. Determining which route through the subnet to use. [1, prob. 16]

3. 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 $s = 2.5 \times 10^8$ m/s, $L=120$ bits, and $R=56$ kbps. Find the distance m so that d_{prop} equals d_{trans}.

4. Consider a packet of length L which begins at end system A and travels over three links to a destination end system. These three links are connected by two packet switches. Let d_i, s_i, and R_i denote the length, propagation speed, and transmission rate of link i, for $i=1, 2, 3$. The packet switch delays each packet by d_{proc}. Assuming no queuing delays, in terms of d_i, s_i, R_i, $(i=1, 2, 3)$, and L, what is the total end-to-end delay for the packet? Suppose now the packet is 1,500 bytes the propagation speed on all three links is $s = 2.5 \times 10^8$ m/s, the transmission rates of all three links are 2 Mbps, the packet switch processing delay is 3 msec, the length of the first link is 5,000 km, the length of the second 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. Suppose two hosts, A and B, are separated by 20,000 km and are connected by a direct link of $R=2$ Mbps. Suppose the propagation speed over the link is 2.5×10^8 m/s.

   a. Calculate the bandwidth-delay product, $R \cdot d_{prop}$.

   b. Consider sending a file of 800,000 bits from Host A to Host B. Suppose the file is sent continuously as one large message. What is the maximum number of bits that will be in the link at any given time?

   c. Provide an interpretation of the bandwidth-delay product.

   d. What is the width (in meters) of a bit in the link? Is it longer than a football field (100 m)?

   e. Derive a general expression for the width of a bit in terms of the propagation speed s, the transmission rate R, and the length of the link m.