HW #1, Chapter 1

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Problem 2. Chapter 1 P6

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 $t = d_{\text{trans}}$, where is the last bit of the packet?

e. Suppose d_{prop} is greater than d_{trans}. At time $t = d_{\text{trans}}$, where is the first bit of the packet?

f. Suppose d_{prop} is less than d_{trans}. At time $t = d_{\text{trans}}$, where is the first bit of the packet?

g. Suppose $S = 2.5 \times 10^8$ m/s, $L = 1500$ bytes, and $R = 10$ Mbps. Find the distance m so that d_{prop} equals d_{trans}.

Solutions:

a. the propagation delay can be represents by:

$$\boxed{d_{props} = \frac{m}{S}}$$

b. the transmission time of the packet d_{trans} can be represents by:

$$\boxed{d_{trans} = \frac{L}{R}}$$

c. Ignoring processing and queuing delays, the end-to-end delay is the sum of the transmission delay and the propagation delay:

$$\boxed{\textbf{End-to-end delay} = d_{trans} + d_{props}}$$

d. At time $t = d_{trans}$, the last bit has just been fully tarnsmitted onto the link but hasn't started propagating yet. **Therefore, the last bit is still at Host A, ready to begin its propagation to Host B.**

e. If $d_{prop} > d_{trans}$, at time $t = d_{trans}$, the first bit has been propagating for d_{trans} seconds. It hasn't reached Host B yet. The distance it has covered is:

$$\textbf{Distance from Host A} = S \times d_{trans}$$

Therefore, the first bit is at $S \times d_{trans}$ meters away from Host A.

f. If $d_{prop} < d_{trans}$, at time $t = d_{trans}$,he first bit has already reached Host B and has been there for:

$$\textbf{Time at Host B} = d_{trans} - d_{props}$$

Therefore, the first bit is at Host B.
g. To find the distance m where $d_{prop} = d_{trans}$ By given, we have:

$$\frac{m}{S} = \frac{L}{R}$$

solve for m:

$$\boxed{m = \frac{S \cdot L}{R} = \frac{2.5 \times 10^8 \textbf{m/s} \cdot 1500 \textbf{bytes}}{10 \times 10^6 \textbf{Mbps}} = 300,000 \textbf{meters}}$$