CO212 - Networks and Communications Tutorial Sheets

Tutorial 1 - Basic Concepts

1. Consider transferring a 1 GB tape using the following mediums. Which is faster, i.e. has a higher data rate?

   (a) A 56 Kbps modem

   (b) Next-day delivery through the postal system

   The modem has a transfer time of

   $$\frac{L}{R} = \frac{1 \times 10^9 \times 8}{56 \times 10^3} \approx 142857 \text{ seconds} \approx 39.68 \text{ hours}$$

   Compared to the postal system, which takes 24 hours, the postal system is clearly faster. However, the postal system has a 24 hour latency (the first bit takes 24 hours to arrive), whereas the modem has very low latency (relatively).

2. Would you use a connectionless or connection-oriented network

   (a) if the underlying network suffers from frequent congested paths? connectionless

   Provides flexibility for routing around congestion.

   (b) for a video conferencing application? connection-oriented

   We want to reserve guaranteed resources, as we want low-latency. The overhead is justified as it will be used for a long-term connection.

   (c) for a short message transfer? connectionless

   We want to avoid the setup overhead found in connection-oriented networks.

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 metres and suppose that the propagation speed along the link is s metres/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.

   $$\frac{m}{s}$$

   (b) Determine the transmission time of the packet d_{tran} in terms of L and R.

   $$\frac{L}{R}$$

   (c) Ignoring processing and queueing delay, obtain an expression for the end-to-end delay $d_{\text{end-to-end}}$.

   $$\frac{m}{s} + \frac{L}{R}$$

   (d) Suppose host A begins to transmit the packet at time $t = 0$. At time $t = d_{\text{tran}}$, where is the last bit of the packet?

   Leaving host A.

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

   In the link, has not reached host B.

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

   At host B.

(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_{tran}.

$$\frac{m}{s} = \frac{L}{R} \Rightarrow \frac{m}{2.5 \times 10^8} = \frac{120}{56 \times 10^3} \Rightarrow m = \frac{120 \cdot 2.5 \times 10^8}{56 \times 10^3} \approx 535714.3 \text{ m}$$

4. Suppose two hosts, A and B, are separated by 20,000 Km, and are connected by a direct link of $R = 2$ Mbps. Suppose that the propagation speed over the link is 2.5×10^8 metres/sec.

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

$$R \cdot d_{\text{prop}} = 2 \times 10^6 \cdot \frac{20000 \times 10^3}{2.5 \times 10^8} = 160000 \text{ bits}$$

(b) Consider as ending a file of 800,000 bits from A to 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?

16000 bits

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

The number of bits that can be on the link at any time.

(d) What is the width (in metres) of a bit in the link? Is it longer than a football field ($\approx$ 105 metres)?

Given the link is 20000 Km, and it can fit 16000 bits, each bit is 125 metres, hence it is longer than a football field.

(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.

$$\frac{m}{R \cdot d_{\text{prop}}} = \frac{m}{R \cdot \frac{m}{s}} = \frac{s}{R}$$

(f) Suppose we can modify R. For what value of R is the width of a bit as long as the length of the link?

Using the expression above, we can solve for R;

$$\frac{s}{R} = m \Rightarrow R = \frac{s}{m}$$